Goddard Procedural Requirements (GPR)

DIRECTIVE NO.	GPR 1860.2A	**APPROVED BY Signature:**	*Original Signed by*
EFFECTIVE DATE:	January 26, 2005	**NAME:**	Edward J. Weiler
EXPIRATION DATE:	January 26, 2010	**TITLE:**	Director

COMPLIANCE IS MANDATORY

Responsible Office: 250/Safety and Environmental Division (S&E)

Title: Laser Radiation Protection

PREFACE

P.1 PURPOSE

This directive establishes the Goddard Space Flight Center (GSFC) laser radiation protection program and contains administrative direction and guidance on organizational and procedural requirements. This directive also provides essential radiation protection information. Other types of radiation are addressed in other documents.

P.2 APPLICABILITY

This directive is applicable to all GSFC personnel, facilities, and activities, including all permanent and temporary sites. This directive shall also apply to all GSFC tenant organizations, contractors, grantees, clubs and other persons operating on GSFC property as required by law and as directed by contractual, grant, and agreement documents.

P.3 AUTHORITY

a. NPD 8710.2, NASA Safety and Health Program Policy
b. National Aeronautics and Space Act, 42 U.S.C. §§ 2451-et seq.

P.4 REFERENCES

a. American National Standard Safe Use of Lasers (ANSI Z136.1).
b. American National Standard Safe Use of Lasers Outdoors (ANSI Z136.6).
c. American National Standard Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources (ANSI Z136.2).
d. Federal Aviation Administration (FAA) Order 7400.2 Procedures for Handling Airspace Matters.
e. GPR 3410.2, Employee Competence and Quality Management System Training.
f. GPR 8621.1, Reporting of Mishaps, Incidents, and Close Calls
g. GSFC Form 23-6L, Request for Radiation Safety Committee (RSC) Action – Laser Radiation Source Personnel Approval.
h. GSFC Form 23-28L, Laser Radiation Source Questionnaire.
i. GSFC Form 23-35LU, Laser Radiation Source – Personnel Approval.

j. GSFC Form 23-67A, Proposal to Conduct Outdoor Laser Operations in Navigable Airspace – FAA Aeronautical Review
k. GSFC Form 23-67B, Laser Configuration for Outdoor Laser Operations

P.5 CANCELLATION

GPG 1860.2, Laser Radiation Protection

P.6 SAFETY

Section 1 (Rules and Responsibilities) addresses safe operating procedures.

P.7 TRAINING

Users and custodians shall be appropriately trained in the safe use of lasers (see Appendix A, Table 1 and Table 2).

P.8 RECORDS

Documentation of training and certification is the responsibility of the appropriate management organization as set forth in GPR 3410.2.

Record Title	Record Custodian	Retention
Supervisory inspection of Class 1, 2, and 3a lasers	Office of Primary Responsibility	*NRRS 8/38A. Retire to Federal Records Center when 6 years old. Destroy when 75 years old.
GSFC Form 23-6L (Approved)	Office of Primary Responsibility	*NRRS 8/38A
GSFC Form 23-35LU (Approved)	Office of Primary Responsibility	*NRRS 8/38A
GSFC Form 23-28L	Office of Primary Responsibility	*NRRS 8/38A
GSFC Form 23-67A	Office of Primary Responsibility	*NRRS 8/38A
GSFC Form 23-67B	Office of Primary Responsibility	*NRRS 8/38A

**NRRS – NASA Records Retention Schedule (NPR 1441.1)*

P.9 METRICS

Metrics will include the number of employees injured by lasers and the number of laser incidents. This data will be reported quarterly to the RSC.

P.10 DEFINITIONS

a. Aviation protection requirements – Requirements that shall be applied to all outdoor laser systems that have a nominal ocular hazard distance greater than 250 feet or have levels in the visible spectrum in excess of those permitted in Laser Free/High Intensity Light/Flight Zone (LF/HIL/FZ) as defined in FAA Order 7400.2, Part 6, Miscellaneous Procedures, Chapter 28, Outdoor Laser Operations.

b. Critical Zone Exposure (CZE) – 5 microW/cm^2; will not produce significant visual impairment.

c. Custodian – A user who has been designated by the appropriate management (section head or higher) and approved by the RSC to assume the responsibility of accountability for sources of hazardous laser radiation.

d. Laser Free/High Intensity Light/Flight Zone (LF/HIL/FZ) – Effective 50 nW/cm^2; indistinguishable from background ambient light.

e. Nominal Ocular Hazard Distance – The distance along the axis of the laser beam beyond which the appropriate maximum permissible exposure per ANSI Z136.1 is not exceeded.

f. Outdoor laser operations – All uses of lasers in operations that involve the laser illumination of any area that is not enclosed by a physical structure. Outdoor laser operations include fixed ground-based systems, mobile ground-based systems, lasers fired through structure openings into outdoor areas, and flight systems (aircraft, balloons, and rocket payloads).

g. Safe Operating Procedures – A local-level procedure document describing safeguards for laser use. Written safeguards shall be posted on or near the laser control panel or at the entrance to the laser-controlled area. Class 1 and Class 2 systems as defined in ANSI Z136.1 are excluded from this requirement unless they are used in navigable airspace.

h. Sensitive Zone Exposure (SZE) – 100 microW/cm^2; will begin to produce afterimage or flash-blindness effects.

i. User – A person designated by management who is approved by the RSC to use Class 3b or Class 4 sources of laser radiation or approved by management for Class 1, 2, and 3a lasers.

PROCEDURES

In this document, a requirement is identified by "shall," a good practice by "should," permission by "may" or "can," expectation by "will," and descriptive material by "is."

1. ROLES AND RESPONSIBILITIES

Goddard Safety Council (GSC) – The GSC shall oversee development, direction, and implementation of GSFC's Health and Safety Program, including radiation protection.

RSC – The RSC is responsible to the GSC and shall oversee development, direction, and implementation of GSFC's Radiation Protection Program. The RSC will appoint a Laser Safety Subcommittee (LSSC) to assist with the implementation of the Program. Approvals may be provided subject to certain requirements or restrictions imposed by the Committee. The LSSC reserves the right to suspend all approvals if the requirements of GSFC's Radiation Protection Program and requirements of approval are not complied with. The Committee may designate a person or persons to give approval for routine requests. The LSSC chairman may act on behalf of the RSC as necessary. All actions shall be reported to the RSC at the next meeting. The LSSC will consist of representatives identified by their directorates as having varying areas of expertise.

The LSSC shall:

a. Meet at least quarterly, and as often as necessary to accomplish its responsibilities;
b. Ensure that laser radiation used at GSFC or under GSFC programs is managed so as to minimize the health and safety risks to Government and contractor employees and the public;
c. Ensure that GSFC and other Federal regulations, professional standards, and sound health physics practices are met;
d. Approve laser operations and, if necessary, prescribe conditions and requirements to minimize radiation hazards;
e. Approve the qualifications of personnel as responsible users and custodians;
f. Approve custodians and users of laser radiation producing devices;
g. Approve safe operating procedures;
h. Review GSFC From 23-6L, Laser Radiation Source Approval, for operational plan and procedure and approve Class 3b and Class 4 lasers. Approvals expire after 3 years; and
i. Review GSFC From 23-35LU, Laser Radiation Source Personnel Approval, and approve personnel to operate lasers. Approvals expire after 3 years.

LSO – The LSO shall:

a. Provide for the inspection of laser radiation use and storage areas;
b. Audit laser source records and evaluate use programs to assure compliance with RSC requirements;
c. Maintain appropriate records of inspections and evaluations;
d. Act on behalf of the LSSC as necessary. All actions shall be reported to the RSC at the next meeting;

e. Require the immediate cessation of operations for any laser activities determined to pose an imminent threat to personnel safety;
f. Provide consultation on Class 3b and Class 4 laser operations as requested;
g. Review and approve Safe Operating Procedures;
h. Review all laser installations (regardless of Laser Class) which involve use in navigable air space.
i. Review all Class 3b and Class 4 laser installations prior to startup of operations and after each approved alteration, and conduct periodic surveys and evaluations;
j. Issue a certification card that will be kept in the user's possession at all times while using Class 3b or Class 4 laser systems;
k. Provide a report to S&E regarding an unintended personnel laser exposure or any objection to propagation of any laser beam by any organization within one hour of notification; and
l. Develop and maintain an inventory of all Classes of lasers that are used outdoors.

S&E – The Chief, S&E has responsibility for laser radiation protection at GSFC (excluding Wallops). S&E shall:

a. Designate the Chair of the RSC;
b. Designate GSFC's Greenbelt LSO;
c. Provide notification to the Agency Environmental Health Officer (EHO) regarding any unintended personnel laser exposure; and
d. Coordinate all matters regarding outdoor lasers, and any satellite laser use with the NASA Senior EHO.

Management – GSFC line management has primary responsibility for the physical safety of personnel working under their jurisdiction and for designating users and custodians of sources of laser radiation. The line manager shall:

a. Assure that laser sources are used only by individuals approved by GSFC's RSC and that all procedures and requirements are met;
b. Ensure that hazard warning signs required by this directive are procured and posted by the user organization under the guidance of the LSO; and
c. Ensure that laser custodians have adequate education, training, and experience for the responsibilities of a custodian.

Supervisors – Supervisors are responsible for employees and projects. Supervisors shall ensure that all facilities and equipment are properly maintained and that employees, where appropriate, are trained and knowledgeable in the proper use of lasers.

Custodian – The custodian shall:

a. Be accountable for sources of hazardous radiation;
b. Ensure the proper use and storage of all sources of laser radiation under his/her custodianship;
c. Post written safeguards on or near the laser control panel or at the entrance to the laser controlled area;
d. Classify all lasers according to their greatest normally accessible level of radiation and in accordance with the ANSI Z136.1 (latest edition), i.e., Class 1, 2, 3a, 3b, or 4;

e. Write Safe Operating Procedures if so designated;
f. Submit all forms for laser use and approval to the LSO at a minimum of 2 weeks prior to need; and
g. Submit immediate reports to the LSO if any departure from laser procedures has occurred (eye or skin exposures greater than the Maximum Permissible Exposure (MPE) limit, any injuries from laser support equipment, and/or any uncontrolled outdoor radiation of a laser beam). See Appendix B for report format required.

Users – Users shall:

a. Obtain certification from the line management responsible for the operations;
b. Use care when employing laser pointing devices displaying a Danger label as they may be capable of causing eye injury to the user or persons in the audience;
c. Submit a GSFC Form 23-35LU to the RSC;
d. Have a baseline eye exam approved by their employer(s). Additional exams shall be administered after any suspected exposure and are recommended upon stopping work with lasers. A baseline or termination eye exam shall consist of:
   (1) Ocular history.
   (2) Visual acuity test.
   (3) Central visual fields test.
   (4) Contrast sensitivity test.

If results of any of the above tests are abnormal, a more in-depth evaluation may be required if determined necessary by the medical provider.

Users of fiber optics communications systems shall follow guidance provided in ANSI Z136.2. Since these systems may contain Class 3b or Class 4 lasers, custodians of open-ended optical fibers and LEDs containing Class 3b or 4 lasers shall seek approval by the RSC through the LSO.

Ancillary Personnel – Ancillary personnel involved in radiological activities shall:

a. Know and follow GSFC radiological safety requirements, environmental statutes, and operations-specific policies and procedures; and
b. Report immediately all unsafe conditions or operations to their supervisor, Facilities Operations Manager, and/or S&E, Greenbelt, or the Wallops Safety Office.

Wallops Safety Office – Wallops Flight Facility shall designate an LSO who shall review and preliminarily approve laser radiation activities at or managed by Wallops. The Wallops LSO shall provide a list of preliminary approvals that have been granted at the quarterly LSSC meetings. The Wallops Safety Office shall:

a. Keep the records for Wallops laser safety;
b. Provide for the inspection of laser radiation use and storage areas, audit laser source records, and evaluate use programs to assure compliance with RSC requirements relating to laser radiation at that facility;
c. Provide all outside coordination for Wallops projects;
d. Review and approve safe operating procedures;

e. Provide notification to the Agency Environmental Health Officer (EHO) regarding any unintended personnel laser exposure; and
f. Coordinate all matters regarding outdoor lasers, and any satellite laser use with the NASA Senior EHO.

Contractor and Guest Professional Operations – Contractors and other personnel operating at GSFC facilities are subject to all provisions of the GSFC Laser Safety Program. Contractors operating at contractor-operated facilities but in conjunction with GSFC programs shall be required to develop a plan to address the hazards of working with laser radiation sources in accordance with ANSI Z136.1 and ANSI Z136.6.

2. LASER RADIATION OPERATIONS APPROVAL REQUIREMENTS

This section defines the requirements for obtaining RSC approval of users, custodians, devices, and operators involved with laser radiation sources. Approval procedures and methods are established to assure that work with sources of laser radiation is performed with due regard for radiological safety.

a. Laboratory Operations – Requests for approval for laboratory operations will be received by LSO at least 2 weeks prior to the work date for adequate processing. Complicated systems, procedures, flight projects, or extremely hazardous operations will take longer to acquire final approval. These systems should be coordinated with the LSO in the early planning stages to assure that there is no impact to mission schedule. For outdoor laser operations refer to section 3 and for offsite activities refer to section 4.

b. Procurement, Manufacture, Alterations, or New Installations of Laser Radiation Sources – When any Class 3b or Class 4 lasers or laser radiation sources are to be procured, manufactured, altered or a new laser installed, a GSFC Form 23-28L shall be submitted to S&E or the Wallops Safety Office. This form should also be used for assistance in the determination of laser classifications.

NOTE: Class 3b laser pointers are not permitted for use at GSFC or its supported facilities.

3. OUTDOOR LASER OPERATIONS

a. All protective systems determinations shall be supported by qualitative and quantitative safety/hazard analysis. Unless otherwise noted, all ANSI Z136.6 recommendations are incorporated by reference as requirements, and will take precedence over any less rigorous requirement in this document. Proposed protective systems shall be submitted to the RSC for approval (GSFC Form 23-6L). All supporting documentation will be included. It should be noted that ALL classes of lasers used outdoors must be approved by the RSC since even Class 1 laser systems may present a hazard to aircraft operators.
b. Laser systems directed towards outer space (which might disrupt orbiting satellites) shall have an approval from the Laser ClearingHouse, Space Defense Operations Center (SPADOC) on file with the RSC. See ANSI Z136.6 for information on which outdoor laser systems require approval from the Laser ClearingHouse. Information sheets for submission to the Laser ClearingHouse are available from the LSO.

c. Federal Aviation Administration (FAA) coordination is required for all operations that will transmit laser energy through navigable air space controlled by the FAA. Coordination with the FAA shall be accomplished through the S&E by submitting GSFC Form 23-67A and GSFC Form 23-67B.

d. Special Requirements: If any organization or other entity objects to outdoor propagation of a laser beam, notification requirements must be followed as shown in Appendix B.

e. Evaluations of outdoor laser operations are the responsibility of the user organization.

f. Access doors to a controlled outdoor laser area and the accessible NOHD ground beam path in which a laser system with greater than 5mW total accessible power is being operated shall be equipped with safety interlocks to prohibit laser beam propagation when the interlock circuit is broken.

g. Personnel access into a controlled laser area containing a laser that has greater than 5mW total power shall be regulated by the use of a Safety Access light. The Safety Access light should be visible through protective eyewear.

4. OFFSITE LASER OPERATIONS

Offsite operations will also be subject to the requirements and regulations of the use site. There has been an extensive proliferation of "local" rules, regulations, and laws throughout the United States and the world in response to public concern over ionizing and non-ionizing radiation. Approval of offsite operations may take an extended time. Offsite laser operations project managers shall appoint a site laser safety officer for the project. This individual will have the authority and the insight to ensure that safe operations are conducted and local regulations met.

5. LASER RADIATION PROTECTION REQUIREMENTS

a. Requirements for control of hazards presented by lasers are located in section 4 of ANSI Z136.1 and are incorporated by reference. The application of control measures for the individual laser classes is shown in table 10 of the aforementioned ANSI publication. Alternate control measures may be approved by the RSC. Adequate justification should accompany the RSC request for approval.

b. Protective eyewear will be relied upon only after all engineering efforts to eliminate the hazard have been attempted. Eye protection for laser hazards shall be reviewed and approved by the LSO. ANSI Z136.1 shall be consulted when identifying and selecting laser eye protective equipment.

c. Control of Associated Hazards (Non-Beam Hazard) – This aspect of laser technology is seldom encountered outside of the research and engineering laboratory and is associated with high power lasers almost exclusively. Non-beam hazards may include electrical, laser generated air contaminants, collateral and plasma radiation, fire, explosions, compressed gas, laser dyes, mechanical, noise, hazardous wastes, confined space, and ergonomics hazards. When these hazards are present, other requirements not addressed by this GPR are likely to apply. ANSI Z136.1 provides requirements and guidance related to these hazards.

6. CAUTION SIGNS, SYMBOLS, LABELS, AND POSTING

a. Except as otherwise authorized by the LSO, signs, symbols, and labels shall use the design and colors described in ANSI Z136.1.

b. In addition to the contents of signs, symbols, and labels prescribed by this section, a user may provide on or near such signs, symbols, and labels any additional information that may be appropriate in aiding individuals to minimize exposure to laser radiation or any associated hazards.

c. Laser warning signs and labels shall be posted as required and in accordance with ANSI Z136.1.

d. Standard operating procedures for Class 3b and Class 4 lasers approved by the RSC and submitted with GSFC Form 23-6L shall be posted on or near the laser control panel or at the entrance to the laser facility.

Appendix A – Training Requirements

Users and custodians shall be appropriately trained in the safe use of lasers (see table 1 and table 2). The following are course objectives:

a. Course A –

(1) Have a basic understanding of laser principles and hazards; and
(2) Understand manufacturers' warnings, hazards, and use instructions.

b. Course B – Accomplish Course A objectives, plus:

(1) Read and understand GPR 1860.2;
(2) Understand basic laser principles;
(3) Know user responsibilities and basic GSFC laser use approval procedures;
(4) Understand principles and properties of laser light;
(5) Understand laser exposure bio-effects;
(6) Recognize hazards;
(7) Understand hazard controls for laser radiation;
(8) Understand exposure control methods (engineering vs. administrative);
(9) Understand the RSC-imposed requirements;
(10) Know basic procedures and methods of handling laser approvals;
(11) Know responsibilities of users and custodians;
(12) Know the inspection and survey requirements; and
(13) Understand consequences of violations.

c. Course C – Accomplish Course B objectives, plus:

(1) Understand advanced laser radiation mathematics;
(2) Know beam characteristics and measurements;
(3) Know hazard zone determinations; and
(4) Understand laser protective eyewear selection.

d. Outdoor Laser Operations – Accomplish Course C objectives, plus:

(1) Gain in-depth knowledge of laser safety, including non-damaging visual effects, emission calculations, and engineering controls required for their safe operation; and
(2) Understand specific operating procedures and safety requirements of the laser installation.

Table 1
Laser User Training and Experience Requirements

Laser Class	Course	Experience*	Approval Authority
1	-	None	Management
2	A	Hands-On Instruction	Management
3a	A	Hands-On Instruction	Management
3b	B	1 Week operational	RSC
4	B	1 Month operational	RSC

** Other requirements may be substituted for experience as determined appropriate by the RSC.*

Table 2
Laser Custodian Training and Experience Requirements

Laser Class	Course	Experience*	Approval Authority
3b	C	1 Week	RSC
4	C	1 Month	RSC
Outdoor Laser Operations	C+**	6 Months	RSC

** Other requirements may be substituted for experience as determined appropriate by the RSC.*
*** Training requirements are specified in Appendix A, paragraph d.*

Appendix B – Accident or Incident Reporting Requirements

Supervisors shall ensure that all individuals, including outside service technicians, understand and follow all controls and procedures as specified by the Center LSO or RSC. Mishaps shall be reported in accordance with GPR 8621.1. Supervisors or lead experimenters shall not intentionally depart from established safety procedures. The laser operators shall keep the supervisor or lead experimenter fully informed of any unintended departure from established safety procedures and of any request to perform unsafe tasks. All departures from established laser procedures shall be reported to the LSO and/or the RSC immediately. This includes all laser eye or skin exposures (greater than the MPE), any injuries from laser support equipment, and any uncontrolled outdoor radiation of a laser beam. Information required in the report includes:

- The nature of the accidental radiation occurrence;
- The location at which the accidental radiation occurred'
- The manufacturer, type and model number of the electronic product or products involved, reference ANSI Z136.6.
- The circumstances surrounding the accidental radiation occurrence, including causes;
- The number of persons involved, adversely affected, or exposed during the accidental radiation occurrence, the nature and magnitude of their exposure and/or injuries and the names of the persons involved;
- The actions, if any, which may have been taken to control, correct or eliminate the causes and to prevent reoccurrence; and
- Any other pertinent information with respect to the accidental radiation occurrence.

Reporting of Objections to Propagation of Laser Beam by Any Organization or Entity

Laser operators who are requested to stop using their laser in outdoor locations by anyone must comply with the request and immediately provide a report of the incident to the LSO.

The LSO will, in turn, notify the Chairman of the RSC and a telephone notification shall be made to the NASA EHO. In no case shall this notification exceed 2 hours from the time the objection is raised. A written report (email or fax) will be prepared as a follow-up to the telephone notification. If the NASA EHO is unavailable, notification shall be to the OCHMO office in Washington, DC, (202-358-1794 or 202-358-2329).

An objection to the use of a specific outdoor laser by the FAA or the U.S. Military shall be honored until the NASA Office of Health and Medical Systems (OHMS), in conjunction with other NASA organizations, review the complaint and authorize continuation of operations.

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
Baseline	06/29/04	Initial Release.
A	01/26/05	Modified to clarify all requirements in accordance with NASA Rules Review Committee recommendations. P.4 added references i, j, and k. P. 9 changed "harmful employee exposures" to "employees injured by lasers" P. 10 added definitions for custodian, user, and Safe Operating Procedure. 1.1 Moved "Safe Operating Procedure" to P.10 Reorganized Section 1 Roles and Responsibilities, from alphabetical listing to a top-down hierarchy. 1. RSC, added the Laser Safety Subcommittee to the RSC 2.a Classification of lasers, moved to custodian responsibility 2.c Laser Radiation Source approval moved to 1.0 RSC and 1.0 Custodian to better define the process. 2.d Laser Radiation Source Personnel Approval approval moved to 1.0 RSC and 1.0 Custodian to better define the process. 2.e User Certification moved to 1.0 User section 3.0 Training Requirements moved to Appendix A 4.0 Baseline and Termination Eye Examinations moved to 1.0 User 5.a deleted 5.b moved to 1.0 LSO Section 6 renumbered Section 3 Section 8 renumbered Section 4 Section 9 renumbered Section 5 Section 10 renumbered Section 6 Added Appendix B, Mishap reporting requirements